The exclusion of marginalized communities in mathematics education in India

Abstract

Mathematics education in India is a complex landscape where the key issue is the exclusion of marginalised communities from mainstream school mathematics. In this paper, by exploring the national curriculum frameworks across the years, this paper unpacks the key discourses around inequalities dominating the field of mathematics education in India. These include the justice-oriented, Hindu nationalist as well as global outcomes-oriented discourses. While we see reflections of all these ideas in different national curriculums, this paper argues that to challenge structural inequalities within mathematics education, there is a need to turn our attention towards everyday pedagogical processes.

Key Words: Mathematics Education, India, National Curriculum, Justice-oriented mathematics, Primary school mathematics

Introduction

Mathematics education in the Indian context is a complex and contested field. In India's post-colonial context, there is a wide range of diversity in the ways in which children experience school mathematics. While almost all children in India now access primary schooling, there is still unequal access to mathematics. Those who belong to marginalised communities (along the axis of gender, caste, religion, etc) are particularly excluded from mainstream school mathematics and systemic exclusion is endemic throughout the schooling system. For instance, beyond free and compulsory education till the age of 13, there is low uptake and high drop-out of marginalised students often due to the 'failure' in mathematics. Furthermore, this inclusion impacts STEM trajectories, as very few marginalised youths pursue mathematics or sciences in higher education (which are dominated by privileged dominant caste community members).

To put issues of exclusion from mathematics into context, this paper aims to delineate the key debates that dominate the field of primary school mathematics. This paper maps out three key strands of debates by exploring India's key national curriculum frameworks. First, discourse around justice-oriented perspectives to mathematics curriculum design and implementation. Second, Hindu nationalist views of mathematics curriculum. Finally, global learning crisis discourse in mathematics education. These three concurrent discourses have historical roots but continue to influence contemporary thought on mathematics education. The paper argues that whilst these are important debates which influences the content of "what" mathematics is taught in schools, there is a need to foreground teachers and pedagogical practices in these debates to understand "how" mathematics is taught. This is particularly crucial in the attempt to create meaningful mathematical experiences for those who are historically marginalised from school mathematics in India.

Key debates in mathematics education through the years: National Curriculum Frameworks 1975 – 2023

In India, the colonial experience has significantly impacted how mathematics curriculum gets framed. The modern education system (that continues in some form

today) came with the colonial establishment of an education system (See Sarangapani, 2014). During the colonial era in India, formal schooling of British colonial knowledge systems replaced indigenous mathematics education systems. By 1835, British textbooks were introduced focusing on transferring Eurocentric mathematical knowledge.

Post-independence, rather than developing an alternative mathematics curriculum, the domination of state regulated curriculum/textbook (often viewed interchangeably) continued to define what mathematics was being taught in schools. In 1961, the National Council for Educational Research and Training (NCERT) was established as an autonomous organisation of the Government of India and was mandated to develop both national curricular frameworks along with textbooks. NCERT has developed five curricular frameworks (NCF1975, 1988, 2000, 2005, 2023) since its inception (Table 1). They are developed by independent committee of experts (often brought together based on the politics of its leadership and larger policy discourse), who come together to formulate and develop curricular aims, objectives, and materials. The national frameworks are critical as they further provide guidance to establishing de-centralised state curriculums, national and state textbooks, and teacher training curriculums. Table 1 outlines the aims of mathematics teaching and learning across these frameworks focusing on the primary school level and highlights the unique discourses prevalent within them. In the following sections the paper unpacks some of these key social and political ideas that have influenced the National Curriculum Frameworks over the years.

Table 1: Comparison of the aims regarding mathematics and role of curricular materials in the different NCFs (1975, 1988, 2000, 2005, 2023)

National Curriculum Framework (NCF)	**Aims of mathematics teaching and learning**
NCF 1975	"In a society which is rapidly transforming itself into an industrial and technological society, mathematical literacy is essential to every citizen" (NCERT, 1975, p. 16).
NCF 1988	"Since quantitative treatment, measurement, analysis and reasoning are being increasingly involved in many other subjects, the relevance should be seen not only as a specific subject area, but also, in the context of, and as concomitant to other concerned subject areas" (NCERT, 1988, p. 23).
NCF 2000	"One of the basic aims of teaching mathematics in schools is to inculcate the skill of quantification of experiences around the learners" (NCERT, 2000, p. 55).
NCF 2005	"NCF-2005 has the following five overarching guiding principles: (i) connecting knowledge to life outside the school; (ii) ensuring that learning shifts away from rote methods; (iii) enriching the curriculum so that it goes beyond textbooks; (iv) making examinations more flexible and integrating them within classroom life; and

	(v) nurturing an overriding identity informed by caring concerns within the democratic polity of the country." (NCERT, 2005, p. viii)
NCF 2023	"In the Foundational Stage, attaining Foundational numeracy (i.e., understanding, and adding and subtracting with, Indian numerals) represents the key focus of Mathematics Education. In the Preparatory Stage, the focus shifts to the development of concepts such as numbers, basic operations (including multiplication and division), shapes, and measurement." (NCERT, 2023, p.176)

Justice-oriented decolonial mathematics curriculum

One of the key goals of early post-independence national curriculum was building a national identity as a recently independent nation. Further, due to the emphasis on industrial nation-building immediately after independence, science and technology subjects were prioritised. This focus meant that while mathematics literacy was deemed relevant to create an industrial and technological society, as a school subject it was viewed more as a complementary/supporting subject for science and technology (rather than being prioritised). For example, NCF-1975 and NCF-1988 clearly stated the importance of mathematics, *because* of science and technology (see Table 1). Slowly frameworks started to explore the importance of mathematics and its worth particularly exploring its relevance for students' lives. For example, NCF-2000 moved to articulating the importance of the application of mathematics in students' everyday lives, and NCF-2005 articulated an active 'shift' in focus of school mathematics towards mathematisation away from the narrower aims of computation.

The shift to mathematics education as an end in itself from being a means to scientific advancement, created room for a justice-based discourse in pedagogy. Slowly a justice-oriented lens to mathematics education started to influence policy as well as curricular development. Unsurprisingly, since there was such great emphasis on the sciences, initially activists started to question the divide between school science curriculum and everyday life realities of youth and children. Additionally, in the 1970s, influenced by the Nuffield science project in the UK and disillusioned by the failure of science teaching and learning in rural parts of India, a group of academic activists started the famous Hoshangabad Science Teaching Programme. This programme collaborated with science teachers and students to develop a meaningful and contextually relevant curriculum instead of using the textbook as the source of all knowledge. It brought with it some of the most foundational ideas of inquiry-based learning as well as questions of contextualising the curriculum, thus calling for a fundamental change in the curriculum-pedagogy relationship prevalent in India. Yet, these curricular innovations initially remained mostly within the sciences.

Efforts in reforming the mathematics curriculum only began in the 1990s. One of the central ideas of these efforts was 'contextualising' the curriculum (much like the effort with science education). For example, the premise of *Numeracy counts!*, a book on adult literacy, was to investigate ways in which adults include mathematical

knowledge in their own work and life (Rampal et al., 1997). What was crucial in these efforts was that both pedagogy (how to learn) and curriculum (what to learn) were being investigated in tandem. Within a postcolonial context, these efforts of 'contextualising' can be viewed as justice-oriented efforts of 'decolonising' the inherited Euro-centric and colonial mathematics curriculum.

These discourses found its space into the national textbooks and curriculum through the NCF-2005, whose committee members consisted of activist academics who had led the above-mentioned initiatives towards justice-oriented mathematics teaching. One of NCF-2005's guiding principles for mathematics education was to *connect school mathematics to the lives and discourses* of the children. While the earlier NCF-2000 mentioned the use of mathematics in students' lives, this was limited to notion of transfer and application of school mathematics in them. For example, NCF-2000 stated, "mathematics helps in the process of decision-making through its application to real-life situations in familiar as well as non-familiar situations" (p. 55). On the other hand, NCF-2005 viewed the links between school mathematics and students' lives through the lens of both critical pedagogy and ethnomathematics. For instance, using a critical approach [In the NCF-2005, an entire subsection (Subsection 2.4.5) is dedicated to explaining 'Critical pedagogy' (p. 17-24)], the curriculum framework explicitly mentioned power issues and systemic discrimination that influences school mathematics. It further talks about the relationship between gender and mathematics. It argues that there is a need to foreground social concerns in the designing of curricula, which would enable children questioning received hegemonic oppressive ideologies (p. 7). Further, through a lens of ethnomathematics, the linking of mathematics and students' lives also meant bringing to the fore "mathematics that people use" (p. 11). The position goes on to state: "What may be called *folk algorithms* exist for not only mentally performing number operations, but also for measurement, estimation, understanding of shapes and aesthetics. Appreciating the richness of these methods can enrich the child's perception of mathematics." (p. 11). Clearly, legitimising and validating alternative forms of mathematics (funds of knowledge) that students experience in their out-of-school lives was also given space within the curriculum, along with critically viewing the relationship of school mathematics and larger social structures. Thus, NCF-2005 influenced by the work of activist academics from science and mathematics education field since the 1970s, spearheaded issues of social justice and equity by proposing linking school mathematics to the lives of children through a critical lens of power and privilege.

Hinduisation of mathematics curriculum

Another parallel effort to making mathematics relevant to school going children has been the proposal to 'look back' to the ancient Indian mathematics. The most significant being introduction of 'Vedic mathematics[1]' into the National Curriculum Framework-2000 (NCF-2000), as an effort to "indigenise" (NCERT, 2000, p. 37, 57) the curriculum. However, this can be viewed as a political effort towards Hindu nationalist agendas. Scholars argue that contemporary Vedic mathematics (fast arithmetic computations) do not really have Vedic origins, but rather, comprises opportunistic rhetoric to promote a certain narrative of Hindu nationalism (Raju,

[1] The term 'Vedic' derives from the 'Vedas' which are Hindu scriptures that were developed over a historic period of 1500-900 BCE. However, 'Vedic mathematics' was first coined by Bharati Krishna Tirtha in 1965 who wrote a book titled the same, and it was falsely claimed to have been derived from the Vedas.

2014). From one perspective these ‘indigenising’ efforts can be viewed as ‘decolonial’ (anti-eurocentrism), yet the Hindu nationalists’ appropriation of the rhetoric of ‘decolonisation’ of education is a contradiction within the Indian postcolonial state.

Furthermore, this discourse homogenises the idea of ancient mathematics in India (as Hindu Vedic Brahmanical) rather than exploring the diverse social practices which differed in different parts of the country. Babu (2012) brings together some diverse forms of historical indigenous practices – including mathematics at work, mathematics at social life (in forms of folk riddles) that support a more heterogenous view of ancient Indian mathematics. Rather than highlighting a particular elite mathematical practice within the Indian community (of the past) everyday mathematical practices of diverse marginalised communities are also acknowledged. This is a particularly useful conceptualisation of the ‘ancient mathematical past’ of India, as it challenges and resists elite discourses or stereotypes of mathematical traditions (eg: particularly dominant caste community members being inherently ‘good’ at mathematics). By acknowledging diverse and marginalised folk-based mathematics traditions, marginalised communities’ funds of knowledge are acknowledged instead of being viewed as deficit. Thus, as Subramaniam (2021) argues homogenous discourses such as Vedic mathematics not only (inaccurately) homogenises the varied histories of mathematics, but actively marginalises religious and caste minorities. Thus, whilst on surface these might seem like decolonising efforts, they reproduce localised social hierarchies. NCF-2005 came out as product of rejection of the earlier policy document of NCF-2000, which was viewed as promoting Hindu Nationalist agenda. Since May 2014, once again the same right-wing Hindu nationalist party has been the ruling political party, that had previously initiated the NCF 2000 reforms. This has severe consequences for the social justice and critical pedagogy ideals that were at the core of NCF-2005. The uncritical appreciation of the “past Indian mathematics” (p.185) can be found in the latest NCF-2023 document, and it remains to be seen how this impacts the ways in which mathematics is viewed and taught in schools. Overall, the idea of ‘indianising’ or ‘indeginising’ mathematics is not a neutral project and must be viewed through the lens of not just global colonial hierarchies, but also from localised social hierarchies.

Global development and mathematics education

Global discourse on the “learning crisis” has significantly influenced Indian policy in mathematics education. India, viewed as a lower-middle-income country of the Global South gets international attention which promotes the need for mathematics education from a human capital perspective. For example, the “learning crisis”, that has been discussed extensively in the last decade, highlights the low level of literacy and numeracy among majority of school going children in India (much like other countries in the Global South). This has been evidenced by large-scale numeracy surveys such as Annual Status of Education Report (ASER) which has consistently found that many school-going children do not have ‘basic’ arithmetic skills (over the last decade). For example, the latest ASER 2022 report shows that across India only 26% of students in Grade 3 (age 7-8) across the country can perform basic subtraction (ASER, 2022). There are in addition also Sustainable Development Goals focus on numeracy, and international outcomes measurement tools such as PISA, TIMSS that put additional pressure on India to focus more on the unequal ‘outcomes’ (rather than processes of inequalities).

This debate is often linked with larger debates around school provisioning, where private and state schools are pitted against each other. The 'lack' of learning outcomes in the state schools is used both to put pressure on governments to improve their provisioning, but also as a means of supporting private schooling systems. However, this debate often overlooks the deeply complex and segregated nature of schooling system that currently prevails in India. Historically, only the elite accessed privately run schools, but the influx of "low-fee private schools" has meant that there is now a range of choices for schooling: from those charging exuberant fees to medium and minimal fees. This has segregated schools (often along the lines of caste, religion, and class) which are now catering to children based on their ability to pay for these options. On the other hand, poorest and the most marginalised students go to government schools, which are free of charge, exacerbating exclusion. Thus, while there is clear evidence of low mathematics outcomes within government schools, this needs to be interrogated against the background of socio-historical marginalisation of children from minoritised communities. For example, there is systemic discrimination against marginalised castes within schools (across different types of provisioning) which continues to exclude children from mainstream mathematics.

In terms of the impact of this discourse on the NCFs, we see a tendency towards setting competency and learning levels for different stages of schooling. For example, NCF-2000 spoke strongly about minimum levels of learning, and in latest NCF-2023, we see the introduction of 'foundational literacy and numeracy'. The aims of these ideas are to introduce rubrics against which 'outcomes' can be measured. For example, the key challenge identified in NCF-2023 is the "large proportion of students in the early grades not achieving foundational literacy and numeracy" (p.179) which has been used to justify the focus on achieving 'foundational numeracy and literacy' till the age of 3. It is also important to note that the focus on age/stages of learning within the NCF-2023 draws strongly from a behaviouralist lens of viewing children and child development. For example, NCF-2023 deems the 'foundational stage' (age 3-8) as developmentally most important. As Sarangapani (2014) argues this behaviouralist influence on policy has been present in the Indian context since the 1980s (through Bloom's taxonomy) and still has significant influence on the education policy. On the other hand, this approach has lesser emphasis on the role of curriculum or textbooks (as was the emphasis during NCF 2005 which took a more social approach to children and learning). Thus, we can see that the NCF-2023 clearly responds to the learning crisis discourse and attempts to create mechanisms for more positive mathematics 'outcomes'. Thus, while outcomes are important indicators of inequality, its overemphasis often distracts from larger systemic educational issues, and creates more individualised (deficit-oriented) discourses.

Need for foregrounding pedagogical practices

The above sections detail the key debates at the policy level in the field of primary mathematics education in India which impacts what mathematics teaching 'should' look. However, the key aspect that is the most neglected in this debate remains teachers and their pedagogical practices. There continues to be a hegemony of curricular policies viewed as a means of reforming mathematics education, where a

lot of attention goes into conceptualising curriculums, developing textbooks, or assessing learning outcomes. While these debates remain important, as it is important to understand the underlying ideological influences on curriculum (often shifting with the change in political power), there is a need to have equal attention to teachers and their practices. The overemphasis on curriculum as a means of reform also tends to view teachers themselves as 'vessels' for change rather than agentic forces. Teaching in India continues to be viewed as a low-status profession, and with very little attention paid to pre-service or in-service training.

While teachers make decisions everyday as they navigate the complex discourses around mathematics education, there is a lack of attention to how teachers negotiate the debates, curriculum, and ideas within their everyday pedagogical experiences. There is both a need to understand teachers' current practices and to empower teachers to become critical practitioners who can have agency to address the localised/contexualised justice-oriented needs of their learners. Particularly in a context where education is highly politicised with multiplicity of reform ideals, understanding how teacher exert their agency of defying/reproducing these ideas is fundamental. Yet, very few empirical studies have looked at how teachers negotiate different curriculums based on their views, institutional realities as well as diverse discourses (Nag Chowdhuri, 2021).

India is a large country, with very diverse socio-cultural contexts, and there is a need for a lot more understanding of how mathematics is taught and experienced within different classroom settings. While we know that students from marginalised communities continue to be excluded from mainstream mathematics, we know very little about their experience of school mathematics and the processes of exclusion. While there are these parallel discourse in mathematics education as explored above (justice based, Hindu nationalist or global outcomes), it is imminent that these are interrogated through the lens of everyday pedagogical practices and its intersection with marginality. If mathematics education in India is truly to become relevant and meaningful for its learners, there is need for much deeper emphasis on pedagogical processes.

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